





TO

# Gauge a Spheroid;

A spheroid is produced by the motion of a semi Ellipsis, about its Transverse axis, and is equal to  $\frac{2}{3}$  of its circumscribing cylinder.

## RULE

Multiply the square of the conjugate axis **CD** into; two thirds of the Transverse **AB** and Divide the Product by the circular Divisors & Quotient will be content,

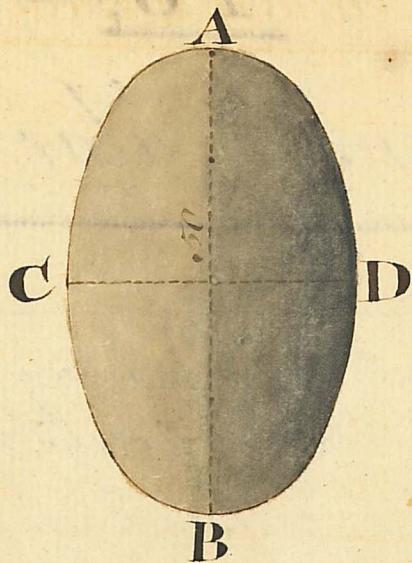
## Or, Which is Better

Multiply the square of the conjugate axis by the Transverse axis and that Product Divided by the Divisors, proper for; a Spheroid will give the content;

Set the Transverse axis **AB** be = 50 Inches and the conjugate axis **CD** = 31. I Demand the content in Ftd. ale; Wine, Malt, and Pounds of Row starch;

$$\begin{array}{r} 31 \\ \times 31 \\ \hline 93 \\ 93 \\ \hline 961 \text{ square} \\ 50 \end{array}$$

3300.25 <sup>rd</sup>	48050	14.55 Quart;
538.5 <sup>rd</sup>	48050	89.22 ale gallons;
441.444	48050	108.91 Wine gallons;
410 <sup>rd</sup>	48050	11.699 Malt Bushels;
66.48	48050	722.773 green or row starch;



By the Sliding Rule;

D	C	D	C	
57.44	50	31	14.55	Feet,
23.2	50	31	89.2	Ale gallons,
AS 21.0	50	31	108.9	Wine gallons,
64.1	50	31	11. <sup>37</sup>	Malt Bushels,
8.15	50	31	722.773	Row Harch,

Gauge P; Diam; Diam; ~ Content

TO

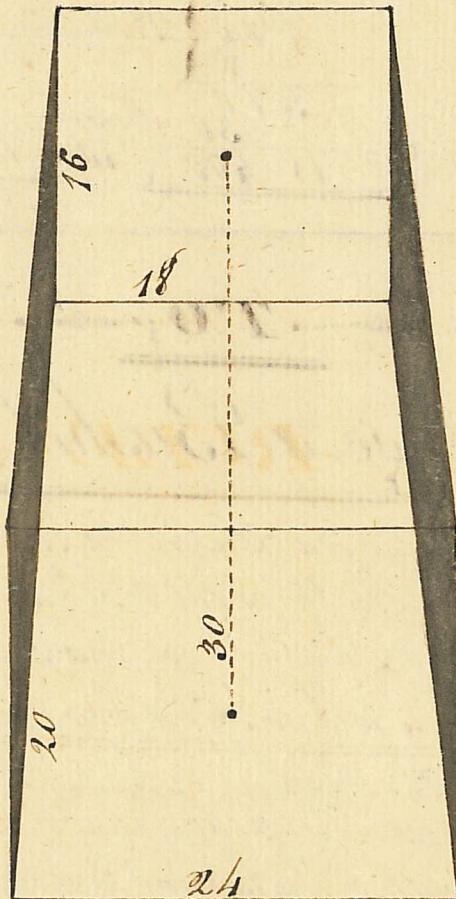
# Gauge; an Irregular Prismoid;

As Vessels in the form of irregular Prismoids are sometimes met with in the practice of Gauging and as several Authors have given Rules that are defective for finding their contents. I shall here give the most certain Method for gauging vessels of this kind.

## RULE

Multiply half the greater Breadth by the lesser Length and half the greater Length by the lesser Breadth; And one third of the Difference of the lengths by the Difference of the Breadths. Then add these three products together. And multiply the sum by the depth the product is the content in Inches. Divided by 282 or 231 gives the content in Ale or Wine Gallons.

If the lower Frustum of an irregular Prismoid whose Breadth at the top is 16 Inches and Length is 18 Inches. The Breadth at Bottom 20; and Length 24 Inches; and the Depth 30 Inches; what is the Content in the gallons;



$$\begin{array}{r}
 10 = \frac{1}{2} \text{ greater Breadth;} \\
 18 = \text{lesser Length;} \\
 \hline
 180
 \end{array}
 \qquad
 \begin{array}{r}
 \frac{3}{3} \text{ Diff. } \frac{30}{=4} \\
 \hline
 3 \cancel{1} - 6 \cancel{2} \\
 \hline
 4 \\
 \hline
 8
 \end{array}$$

*Answ.* 40. A ale gallons;

$$\begin{array}{r}
 12 = \frac{1}{2} \text{ greater Length;} \\
 16 = \text{lesser Breadth;} \\
 \hline
 72 \\
 \hline
 12 \\
 \hline
 \left. \begin{array}{r} 19^2 \\ 180 \\ 8 \end{array} \right\} \text{Products;} \\
 \hline
 380 \\
 \hline
 30 \text{ Depth;} \\
 \hline
 282 \boxed{11} 400 \quad 40.4 \text{ ale gallons;}
 \end{array}$$

TO;

## Gauge, a' Bushel;

Suppose the Diameter of a Bushel be 10 Inches and the Depth but 4.58. The Depth ought to be 4.58 Inches to be equal to the Standard, and therefore you may conclude such a Bushel is too little, how to find how much it wants, say;

As 4.58 Inches, the Depth;  
 Is to 32 The Quarts in a Bushel;  
 So is 4.58 The Depth of the Bushel given  
 To 29.9 Quarts, Content;

32 Quarts in a gall;  
 29.9 Content;  
 -2.1 less than stand;

# Example;

2. But suppose you would have a Bushel 16. Diameter; What Depth must it be; to be equal to the Standard Bushel,

## RULE

Divide Unity, or one Bushel by the area of the given Diameter and the Quotient is the Depth that will make, a Bushel of that Diameter;

Diameter 16. } Inches,

$$\frac{16}{2738} \left( \frac{16}{2.56,0000} \right) \text{dred; Unity; } 1.00000 (10,7) \text{ Depth to 10.}$$

Inches and almost three Quarters and so Deep a Bushel must be that is 16. Inches Diameter, to be Equal to the Standard But this is more expeditiously performed by the Sliding rule on the lines **C** and **D**; **VII**,

Set 16 the given Diameter on **D**, to upon, **C**, and against the Gauge point 52.32 on **D**, is 10,7 the Depth upon, **C**; &c;

TO;

Gauge all sorts of open Vessels;

As Tuns, Backs, Coolers, Coppers, &c;

Mash Tuns and guile. Tuns are generally the frustum  
of cones and it matters not whether they stand upon the  
Slop or greater Base for the method of gauging them is same

RULE

With your sliding cane take the Diameter in the middle  
of every 10 Inches from the Bottom upwards and enter  
them with their Areas in ale gallons in your Dimen-  
sion Book which will be a Table for that Tun.

OR

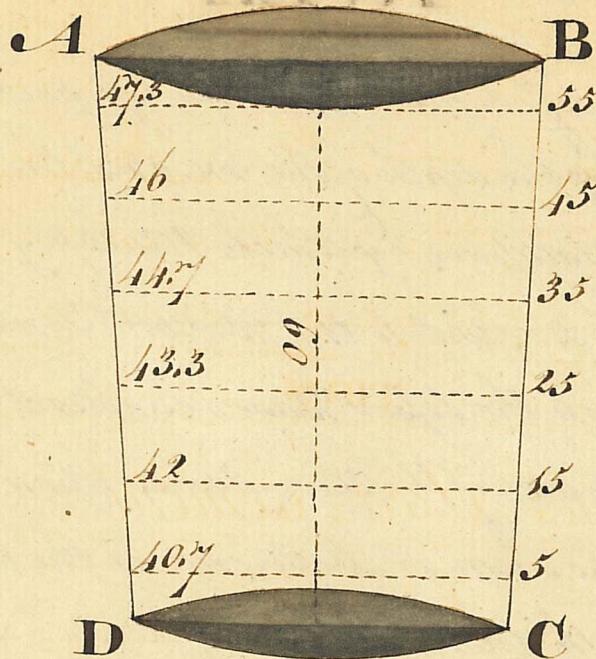
The Diameter may be found in any part thereof by know-  
ing the Depth and the Top and Bottom Diameters by this:

# RULE

Divide the difference between the top and Bottom Diameters by the depth of the ton, and the Quotient is a common Multiplier by which Multiply any depth; and add the product to the Bottom Diameter if the Sun stands on the lesser Base or subtract it from the Bottom diameter if the Sun stands upon the greater Base and the sum or Difference is the true Diameter at the Depth then taken.

## Example

Set the depth **EF** be 60 the top diameter **AB**=48 and the Bottom **CD**=40 Inches; I demand the diameter of the Middle of Every 10 Inches from the Bottom upwards and also how many ale gallons the Sun will hold;



$$\begin{array}{r}
 18 \} \text{Diameters} \\
 10 \\
 \hline
 60 \quad 8 \\
 1333 \quad \text{common multi}^2 \\
 .5 \\
 \hline
 666.5 + 40 = 40.7 \text{ Diameters at } 5 \text{ Deep; } \quad 2.999.5 \\
 \hline
 \underline{42,0000 \text{ Diam. at } 15 \text{ deep}}
 \end{array}$$

$$\begin{array}{r}
 1333 \\
 .25 \\
 \hline
 666.5 \\
 2000 \\
 333.25 \\
 40 \\
 \hline
 43.332.5 \text{ Diam. at } 25 \text{ Deep; } \quad 44.7000 \text{ Diam. at } 35 \text{ deep.}
 \end{array}$$

1333  
~~45~~  
~~6605~~  
 equal to ~~5332~~  
 6,9985

1333  
~~55~~  
~~66,65~~  
~~6605~~  
 7,3315

16.000 Diam at 45 Deep;      16.000 Diam at 55 deep

Now by the Sliding Rule, find areas as I have taught, in Lead  
 Beaten & royal gauge, Page 33, in ale gallons and will stand

**THUS**

**Diameter, Area, Content**

47.3	6.23	62.3
46.0	5.89	58.9
44.7	5.56	55.6
43.3	5.22	52.2
42.0	4.91	49.1
40.7	4.61	46.1

The sum is the Content of 324.2 Ale Gallons

TO,

# Find the Drip or Fall of a Sun;

Find the Drip or Fall of a Sun is when it is set a little sloping on one side, for convenience of cleansing so that when that when the bottom is just visible at **D**: The other side **BC**, is part covered; draw the line **FE** parallel to the Bottom; **CD** and then it is plain that when the Sun stands in this oblique position the Quantity of wet equal to, **CD**, is not half of **CDEF**. because the Sun stands upon its lesser Base but if it ad stood upon its greater Base the Quantity would more than half **CDEF**. and if the Sun had been a cylinder the two Quantities, viz, **CDE** and **DEF** would be equal; Now if we find the content of the part **ABG** and subtract from the Suns content we shall have the Quantity of Liquor that will up the Sun to **B**. so that the Liquors surface will then be represented by the line **GB**;

TO;

Find the slant Height of any open;  
TUV;

RULE.

To the square of the Depth, add the square of half the difference of the two Diameters and the square root of that sum is the slant Height, by which I find  $AD = BC = 60.13$  and  $EC = 15.5$  Inches; And as it is shewn in last Rule, I find the Diameter  $GH$ , to be 45.5 and  $FE$ , 42.1;

NOTE;

If the vessel is empty and you would find the point **G**; that is, where the surface of the liquor would cut it were filled up to **B**, it may be done by the help of a Quadrant such as I have described in, for looking, thro' the sight at **B**, and the Thread falling at the Beginning of the first Degree in the limb your sight will then be directed to the;

Point **G**, where you may make a mark with chalk, ~  
Measure the distance **AG**, with your gauging cane, ~  
Which I suppose to be 17.5 then find **AL**, and it will hold n.

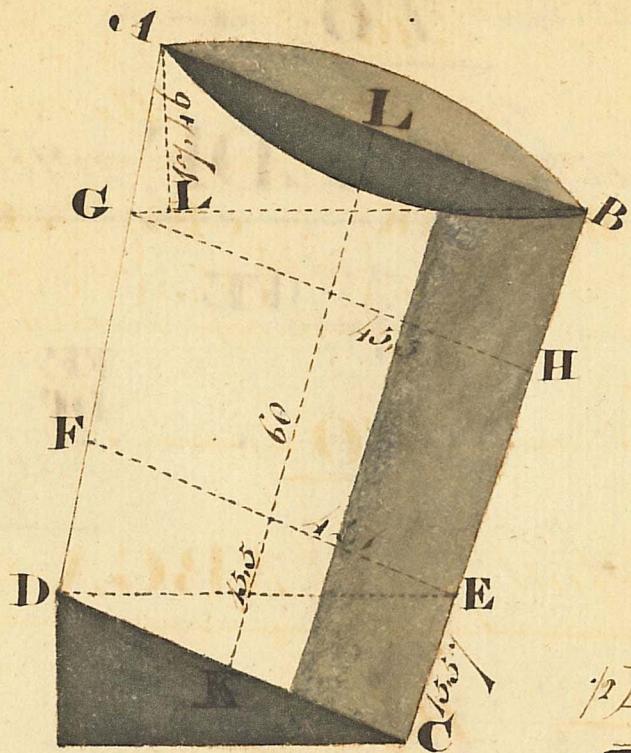
$$\text{As } \left\{ \begin{array}{l} \text{AD} \\ 60,13 \end{array} \right\} \text{ is to } \left\{ \begin{array}{l} \text{IK} \\ 60 \end{array} \right\} \text{ so is } \left\{ \begin{array}{l} \text{AG} \\ 17.5 \end{array} \right\} \text{ to } \left\{ \begin{array}{l} \text{AL} \\ 17.16 \end{array} \right\}$$

TO

Find what part ABGA, will hold,

RULE

To the square of the top Diameter **AB**=48 add one half of  
the rectangle, or product of the top and bottom diameters  
Multiply the sum by the Depth **AL**, and divide the pro-  
duct by 1077.15 for ale, and by 882.35 for Wine;



$$\begin{array}{r}
 45.5 \\
 - 48 \\
 \hline
 3640 \\
 - 1820 \\
 \hline
 121840 \\
 - 1092 \\
 \hline
 \end{array}$$

$$\begin{array}{r}
 18 \\
 - 18 \\
 \hline
 384 \\
 - 192 \\
 \hline
 2304 \\
 - 1092 \\
 \hline
 3396 \\
 - 1746 \\
 \hline
 20396 \\
 - 13584 \\
 \hline
 6712 \\
 - 2372 \\
 \hline
 3396
 \end{array}$$

Tuns content... 324.2  
 Subt. ABGA ..... 56.12  
 Remains: BCDG = 270.08

$$10^{\text{m}} \frac{17.5}{15} 58294.16 \approx 54.12 \text{ ale gallons.}$$

TO  
Find what, FEDE, will hold.

42.1  
42.1 } FE  
42.1  
842  
1684  
17y 2.45  
842  
2614.41  
15.33 Depth

FE = 42.1  
DC = 10  
1684.0  
842

107y. 15) 40601.7 873 (3y. 69 ale gallons;  
11 ) 32314.5  
- 828 7 28  
54005  
= 747 237  
646296  
1009473  
969435  
= 10038 Remains

TO

Find how much Liquor will cover  
the Bottom, viz, part DECD;

$$\begin{array}{r} 40 \\ 40 \{ \text{DC} \\ \hline 1600 \\ 842 \\ \hline 2442 \\ 1553 \text{ Depth} \\ \hline 9326 \\ 12210 \\ 12210 \\ 2442 \\ 1077.15) 34924.26 \\ \hline 32314.5 \\ = 560976 \\ 53854.5 \\ \hline = 224010 \\ 215430 \\ \hline = 858000 \\ 154005 \\ \hline 103995 \text{ Remd.} \end{array}$$

**FE** = 42.1  
**DC** = 40  
 $\frac{1}{2} \sqrt{1684.0}$   
842.0

$$\begin{array}{r} \text{FEDF} = 37.69 \{ \text{ ale gallons,} \\ \text{DECD} = 35.21 \{ \text{ ale gallons,} \\ \text{DCEFD} = 37.290 \end{array}$$

TO

Gauge a Mash-Tun;

If you square the Diameters, and divide by 299.47 the  
Quotient will be the area in gallons; which Divide by 8,  
gives the Bushels of malt brewed; see the last figure but one;

Set the Diameter of the Tun above mentioned by as is there  
Expressed in the Rule but one before; how many Bushels  
of Malt, goods doth it contain?

Diameter;	
48.0	
47.3	
46.0	
44. <sup>7</sup>	
43.3	
42.0	
40. <sup>7</sup>	
40.0	
	352.0
	352.0
	<u>704.0</u>
14.6.0	
10.5.6.0	
299.47	1239010
	8
	110
	5 1/4 Amt. Malt bushels;

TO

## Gauge a Back or Colder.

A Back or colder, is square or oblong made of Wood, &c  
about 6, 8, or 10. Inches deep into which the Boiling -  
Water is set out of the copper for more expedition in cooling.  
Common Brewers have under Backs, i.e. one under another.  
Most Backs have their sides straight and in case the  
sides be not straight, But make either an obtuse or acute  
angle with the bottom, you must then be careful to  
take the true length and breadth in the middle of  
Every inch in depth, from whence the area may be  
found upon every Senth;

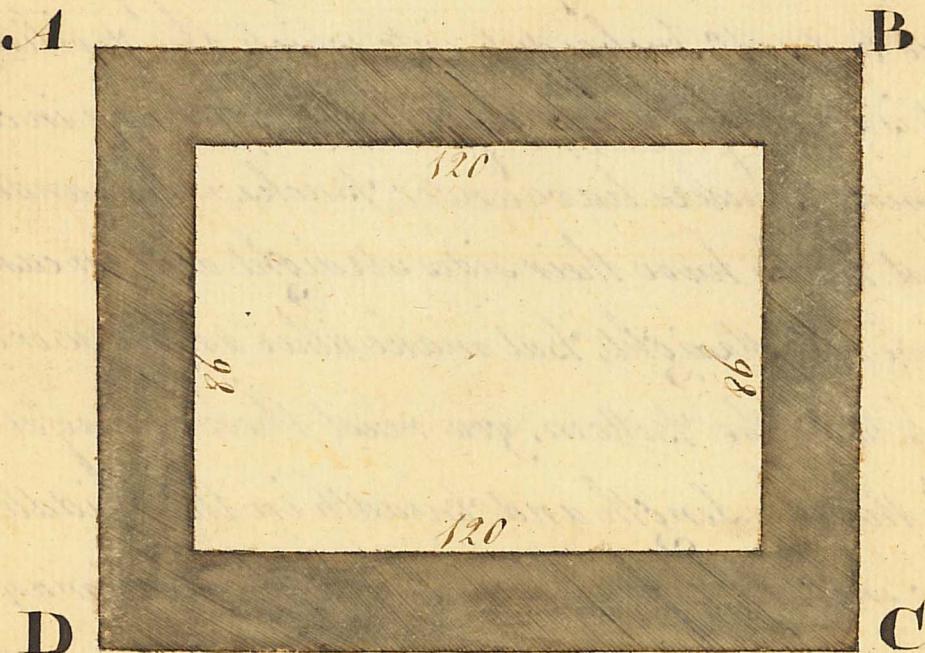
For finding the Area of the Back, observe; -

### RULE

Multiply the Length by the Breadth, and Divide by 282;  
This gives the content in ale gallons;

Set the length **AB** be 20, and **BC**, 86. Inches What is  
The Area in Ale gallons.

$$\begin{array}{r} 120 \\ 86 \\ \hline 36 \\ 282 ) 10320 \end{array} \quad \underline{\underline{36.59 \text{ ale gallons. Ans.}}}$$



TO

## Gauge a Copper with a Rising Crown;

In London the common Brewers coppers are all made with rising crowns, which they tell are made so, that the liquor and West may boil the sooner;

### How to take the Dimensions;

1. Try if the copper be perfectly round, Then let two assistants hold a packthread right over the Middle from **A** to **C** and take the Diameter **AC** which suppose is **b**;
2. Hang one plumb line at **M**, and another at **N**, take the Depths **MF** and **NG** each = 51 Inches;
3. Take the Distance **AM** = **NC** = 10.25. Where sum = 20.5 taken from **AC** = **b**. Sheer rests **FG** = 10.5 The Diameter of the Crown;

4. Now to find the content of the Copper from the crown upwards, viz. The part **ACDE**. The depth **BH**. being 39 Inches. Find a Diameter in the Middle of every 4-Inches, for the more the Better where the copper is large, and place them with their Areas as in following:

## TABLE.

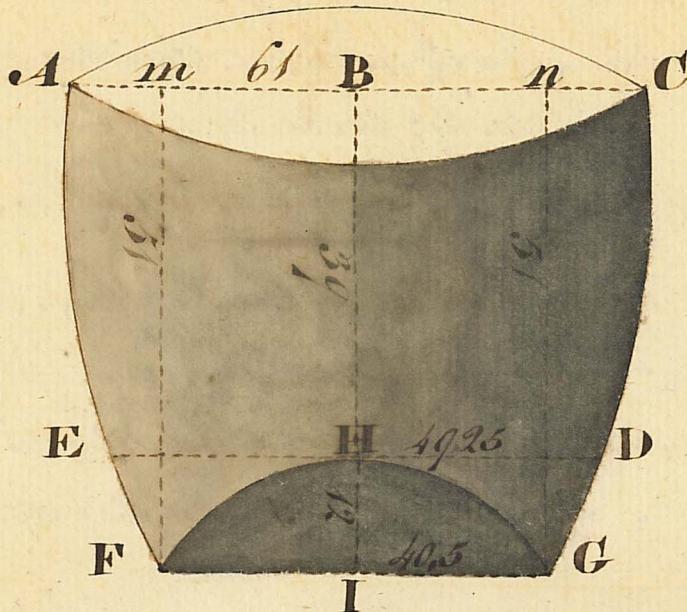
Parts of the shell depth	Diameter	Area in one gallons	Content of weight inches B. F. G
3	61.5	10.53	8.. 3 .. 6.00
4	62.5	10.88	1.. 1 .. 1.02
4	62.0	10.71	1.. 1 .. 0.34
4	61.5	10.53	1.. 0 .. 8.12
4	60.5	10.10	1.. 0 .. 6.76
4	59.5	9.76	1.. 0 .. 5.44
4	58.5	9.52	1.. 0 .. 4.12
4	56.5	8.89	1.. 0 .. 1.56
4	54.5	8.24	0.. 3 .. 4.58
4	52.5	7.68	0.. 3 .. 5.22
<u>39</u>		<u>sum =</u>	<u>11.. 0 .. 3.75</u>
To cover the Crown			1 .. 0 .. 2.90 <sup>1/2</sup>
Content of the copper			<u>12.. 0 .. 6.65<sup>1/2</sup></u>

First. Place the parts of the Depth. Next. the Diameter  
in the Middle of every 4 Inches. then the Areas of those  
Diameters; and lastly. the contents of Every 4 Inches.  
Reduced to Barrels. Hhds. and gallons.

5. Multiply every Area by the Depth  $\frac{1}{4}$ : and reduce  
the Product into Barrels. Hhds. and gallons: only  
the top mean Area is taken in the Middle of 3 Inches  
Therefore it is multiplied by 3. and its product reduced.

6. To find what Quantity of Liquor will cover that  
Will cover the Crown that is. the part **FEHDGF**.

First. Find what the Shrustum **FEDGE**. will hold  
and also the content of the crown **FHGIE**; it being;  
gauged as the segment of a globe; which content,  
Being subtracted from the Shrustum **FEHDGF**,  
Will leave the part **FEHDGH**; i.e) what will cover  
the Crown;



For the Frustum, FEHDGF;

$$\begin{array}{r}
 19.25 ED \\
 10.5 FG \\
 \hline
 24.625 \\
 - 19.400 \\
 \hline
 19.94625 \\
 \quad \quad \quad 3 \\
 \hline
 5.983.875 \\
 \quad \quad \quad 1.5625 \\
 \hline
 6.060.4375 \\
 \hline
 107\frac{1}{2}, 15 \quad \boxed{19.925, 2500} \quad 67.525 \text{ Ale Gallons.}
 \end{array}$$

# For the Segment of the Globe. FHGIE,

$\begin{array}{r} 20,25 \\ - 20,25 \\ \hline 00 \\   \\ 10125 \\   \\ 1050 \\ \hline 40500 \\   \\ 410,0625 \\   \\ 36 \\ \hline 24603750 \\   \\ 12301845 \\ \hline 144622500 \\   \\ 14280000 \\ \hline 538,575 \\ \hline \end{array}$	$\left\{ \begin{array}{l} \text{IG} \\ \hline \text{H} \\ \hline 111 \\   \\ 11 \\   \\ 1728 \text{ bale of HI-} \\   \\ 12 \\   \\ 36 \text{ Hrible HI-} \\ \hline \end{array} \right.$
$101,002,500$	$30,618 \text{ ale Gallons.}$

From **FEEDGIF** — **b7,525** Ale Gallons,  
Subtract **FHGF** — **30,618** D.  
Remainder **FEHDGH** — **36,907** Which will cover y<sup>e</sup> Brown

TO  
Gauge a Still;

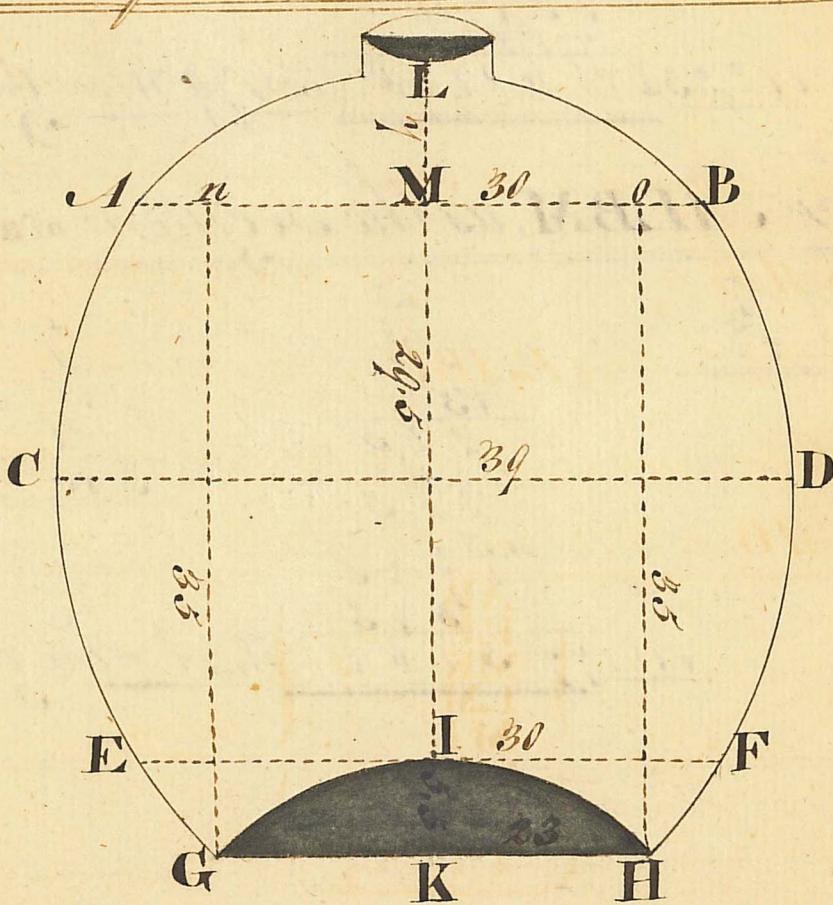
Stills are generally made with rising crowns at  
the copperware and must be divided into such figures  
as according to your judgment you think they  
nearest approach to. so in the still before us, the  
part **ALB** must be gauged as the segment of a globe,  
the middle part **E.ABE** as the middle frustum of a  
spheroid, and the lower part (as in the copper) =  
**GEEFHG**, as a parabolic concid;

<u>Set -</u>	{	$\begin{array}{l} AB = 30 \\ EF = 30 \\ MK = 35 \\ LM = 4 \\ MI = 29.5 \\ IK = 5.5 \\ GH = 23.0 \\ CD = 39.0 \end{array}$	} <u>Inches:</u>
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- How many wine gallons will the still hold:-

# RULE;

To twice the square of **CD**, add once the square of **AB**.  
Multiply the sum by **MI**, and divide the Product by  
882,354. That is three times 294,118. and the Quotient  
is the Content of that Part in Wine gallons.



*CD* { 39  
39  

---

35 1

11<sup>r</sup>  

---

15 2 1

---

3 0 4 2

---

0 0 0

---

3 0 4 2

---

2 0 5

---

1 0 7 1 0

---

3 5 4 8

---

7 8 8 4

882,354 11 6 2 8 9,0 [131,79 Wine gallons.]

*AB* { 30  
30  

---

9 0 0

For ALBM, as the Segment of a Globe.

7  
3  
2 1

15  
15  
7 5

15  
2 2 5  
2 1

2 2 5  
4 5 0  
4 7 2 5

4 5 0  
3 4 3

7  
7  
1 9  
1 7

3 4 3 The cube.

446,177 5 0 6 8 [11,48 Wine gallons.]

FOR;

The Part EIGHG. viz. what will  
cover the Crown,

EF = 30 its Area in wine gall. = 3.05

IK = 5.5 its Area = 102. 1/3 of its Area, = 13 1/3

Remainder 2. 01 1/3

Half of IK = 2. 1/3

1 1/2 1/3

2 0 3 0 1

Will cover the Crown EIGH = 5.82 1/2

= 8.01 0 1/2 5 = IG;

ECABDF = 131. 790 0 0

Add ALB, A = 16. 180 0 0

The content of the still 51. 280 1/2 5 Wine Gallons

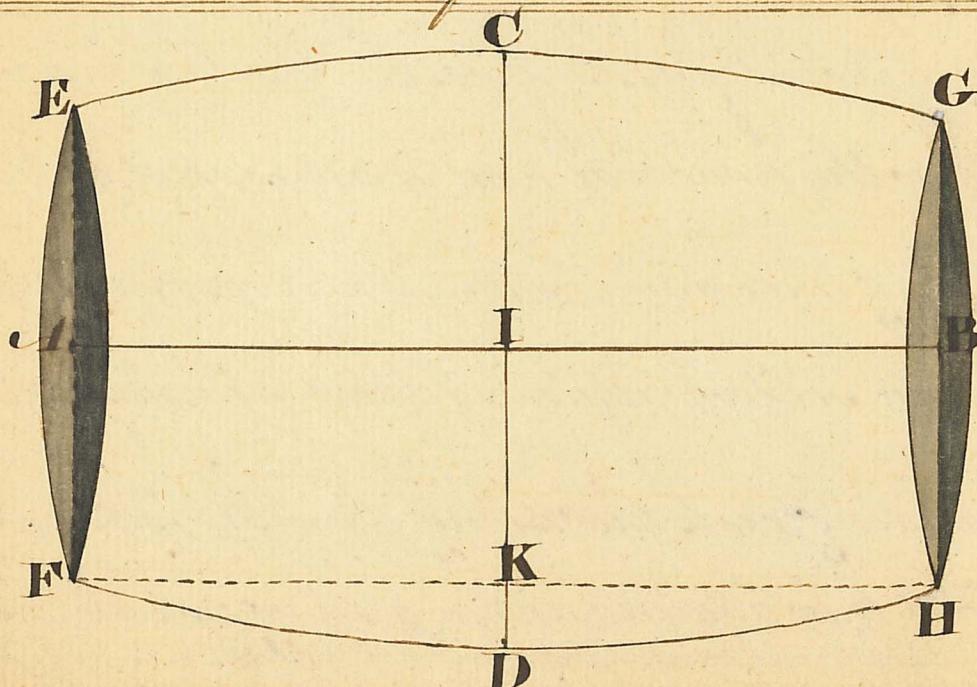
30  
23  
(12) 53  
2 6. 5  
2 6. 5  
1 3 2 5  
1 5 9 0  
5 3 0

Divide 31 = 1 7 0 2 2 5 (3.05 Nearly;

# CASK, GAUGING

This is the most difficult part of gauging because no general rule can be prescribed to find the true content of all sorts of casks, by reason of the uncertainty of their curvature. But before we consider the different forms of casks it will be necessary to shew the practical and most correct methods of taking their dimensions. When casks are full you can seldom attain all their dimensions. In a standing cask the bung diameter is the most difficult to be attained, and in a lying cask the length

Suppose the Bung Diameter of a cask be 31 -  
Inches the head diameter 25 Inches, and the -  
Length 46 Inches and that laying the square -  
over chimes the square touches the chimes at -  
3.5 Inches and exactly at half way between the  
Chime and the mark at the Bung the distance  
From the side of the square, from the staff is 8.  
I demand the Form of the cask.



# RULE

---

To the sum and half sum of the squares of the Bung  
 And head Diameters, add half the difference of  
 The said squares the sum of these multiplied by  
 The length, and the Product divided by 1099.15  
 For Ale, and by 882.354 for Wine gives the cont;

$\frac{3}{2} \{ CD,$	$\frac{25}{2} \{ EE,$
<u>31</u>	<u>12.5</u>
<u>93</u>	<u>50</u>
<u>961</u>	<u>625</u>
<u>1625</u>	
$\frac{1}{2} 15.96$ sum;	961
$\frac{1}{2} 9.375$ sum;	625
$\frac{1}{2}$ diff. of the squ; 1.68	$\frac{1}{2} 33.6$
$\frac{25}{2} \frac{1}{2}$ The sum;	<u>168</u>
<u>The cask's length 16</u>	
15282	
10288	
1099.15	100.6 Ale Gallons;
882.354	153.9 Wine Gallons;

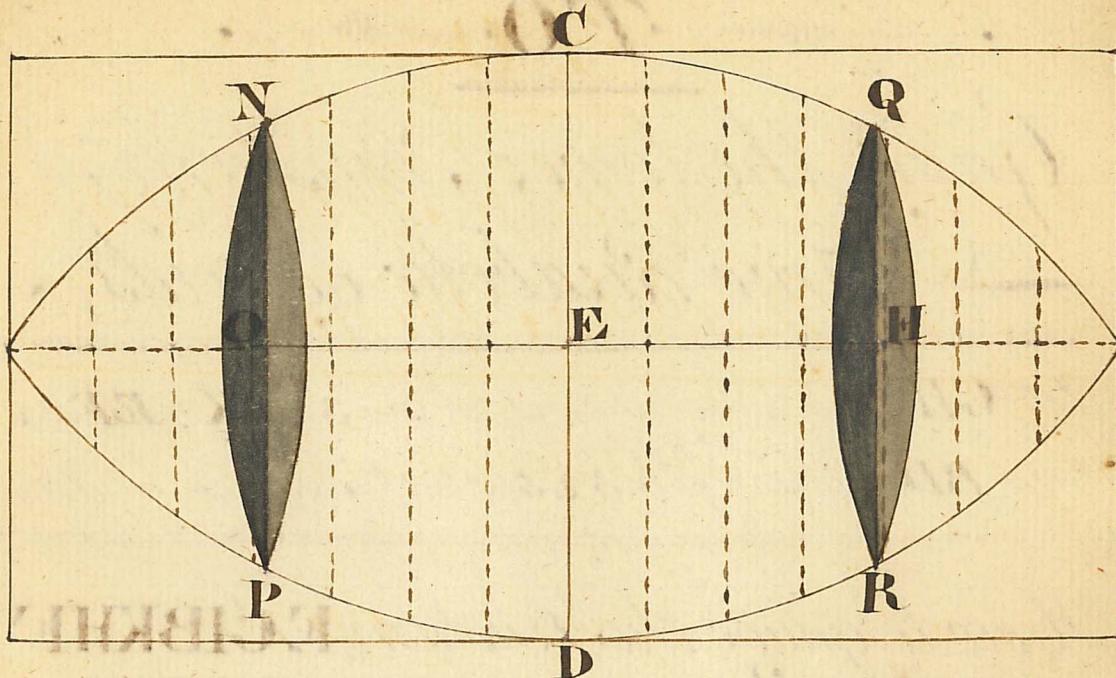
TO;

Gauge the middle Frustum  
of a Parabolic Spindle; —

To describe a Parabolic Spindle in Plan the mid-  
dle Frustum, whereof shall represent a Cask.  
Whose diameter at the Bung; **CD**=31 Inches.  
The diameters at the heads **NP** and **QR** are  
Each - 24 Inches, and the length 32.5 Inches.

RULE

To twice the square of the Bung diameter, add the  
square of the head diameter. From that sum take  
four tenths of the square of the difference between  
the head and Bung diameters, multiply the  
remainder by the length of the cask within  
and divide the product by 10<sup>10</sup>/<sub>15</sub> for ale gallons.



<u>CD</u> <u>31</u>	<u>CD</u> <u>31</u>	<u>MP</u> <u>24</u>
<u>NP</u> <u>24</u>	<u>31</u>	<u>24</u>
<u>Difference</u> {	<u>31</u>	<u>9</u> <u>6</u>
<u>1</u> <u>9</u>	<u>9</u> <u>3</u>	<u>4</u> <u>8</u>
<u>1</u> <u>9</u> <u>4</u>	<u>9</u> <u>9</u> <u>2</u>	<u>5</u> <u>7</u> <u>6</u>
<u>1.0</u> ) <u>19.6</u>	<u>19.2</u> <u>2</u>	.
<u>19.6</u>	<u>5</u> <u>7</u> <u>6</u>	
	<u>2</u> <u>5</u> <u>9</u> <u>8</u>	
	<u>19.6</u> <u>4</u>	square of difference
	<u>2</u> <u>4</u> <u>8</u> <u>4</u>	
	<u>3</u> <u>2</u> <u>5</u>	The strength <u>OE</u> =
	<u>1</u> <u>2</u> <u>3</u> <u>9</u> <u>2</u> <u>0</u>	
	<u>4</u> <u>9</u> <u>5</u> <u>6</u> <u>8</u>	
	<u>7</u> <u>1</u> <u>3</u> <u>5</u> <u>2</u>	
<u>10</u> <u>7</u> <u>15</u>	<u>8</u> <u>0</u> <u>5</u> <u>4</u> <u>8</u> , <u>0</u> <u>0</u>	<u>7</u> <u>4</u> , <u>7</u> <u>8</u> Ale. Gall.
<u>8</u> <u>8</u> <u>2</u> , <u>3</u> <u>15</u>	<u>8</u> <u>0</u> <u>5</u> <u>1</u> <u>8</u> , <u>0</u> <u>0</u>	<u>9</u> <u>1</u> , <u>2</u> <u>8</u> Wine <u>g</u>

**TO**

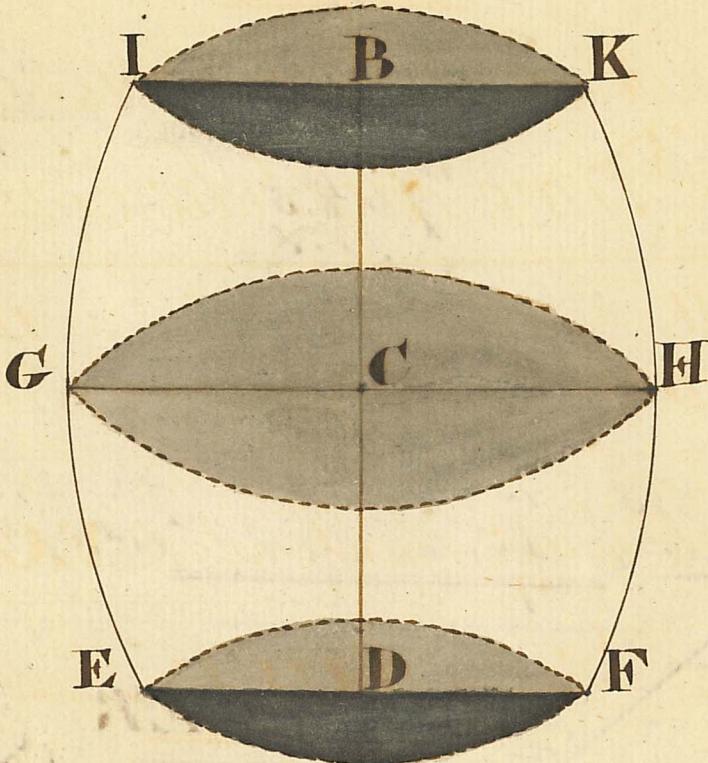
Gauge the lower Frustum of  
Two Parabolic Conoids;

Let **GH**, the Bung diameter be - 31. **IK = EF** 24,  
and **BD**, the length 32.5 what is conten in ale;

How to gauge the Frustum, **ECIBKHF**

**RULE**

To the sum and half sum of the square of the  
Bung and Head diameters add  $\frac{1}{10}$  of the diff<sup>e</sup>  
of the said squares multiply the sum by the  
length within equal to **BD** and divide by 1077.  
15. for Ale and by 882.35 h. for Wine Gallons;



Example;

Let the dimensions be the same as in the spheroid and parabolic spindle, viz. the <sup>long</sup> diameter 31 inches the Head  $FE = IK = 24$  and the Length  $BD 32.5$ . what is content in ale and wine;

31  
31  
31  
9 3  
9 6 1  
5 7 6  
15 3 7  
7 6 8 .5  
3 8 .5  
2 3 4 1 .8  
3 2 .5

2 4  
2 4  
9 6  
4 8  
5 7 6

K  
 II.  
 10<sup>44</sup>,15      12 618 600      70.<sup>42</sup> Ale Gallons  
 88<sup>24</sup>,354      12 618 000      86,<sup>34</sup> Wine Dr.

A V S W E R.  
 10.<sup>42</sup> Ale Gallons  
 86,<sup>34</sup> Wine Gallons

TO;

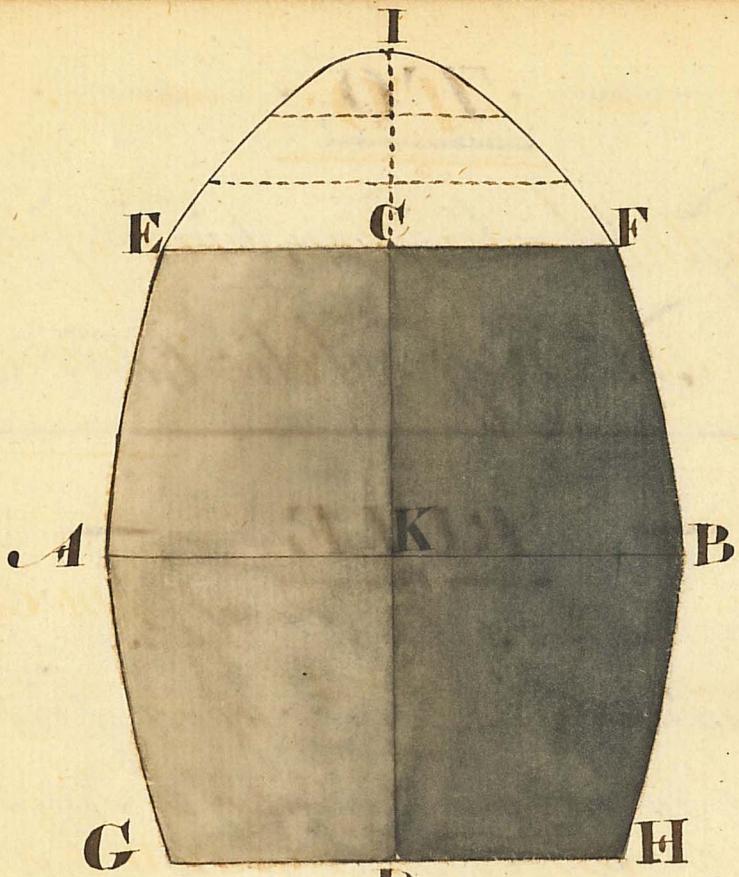
Gauge the lower Frustum of  
Two Hyperbolic Conoids.

RULE;

To the sum of the squares of the Bung and Head Diameters add the product of the Bung multiplied by the head diameter this sum multiply by the length of the cask within and divide the Product by 1077.15 and 882.354 = This will give the content in Ale and Wine,

Example;

Set the head = 24 Bung 31 and Length 32.5 Inches as in the other Casks above what is the content &c



$$\begin{array}{r} 24 \\ \hline 24 \\ \hline 96 \\ 18 \\ \hline 546 \end{array} \quad \begin{array}{r} 31 \\ \hline 24 \\ \hline 124 \\ 62 \\ \hline 244 \\ \hline 1 \end{array}$$

$$\begin{array}{r} 31 \\ \hline 31 \\ \hline 31 \\ \hline 937 \\ 961 \\ \hline 56 \\ 744 \\ \hline 2281 \\ 32.5 = CD \end{array}$$

1044.15	<table border="1"> <tr> <td>4132.5</td> </tr> <tr> <td>4132.5</td> </tr> </table>	4132.5	4132.5	68.82 ale gall.
4132.5				
4132.5				
882.351	<table border="1"> <tr> <td>84.02 Wine Dr.</td> </tr> </table>	84.02 Wine Dr.		
84.02 Wine Dr.				

# TO

Gauge the lower Frustum of two  
Cones abutting upon one common  
B. A S E,

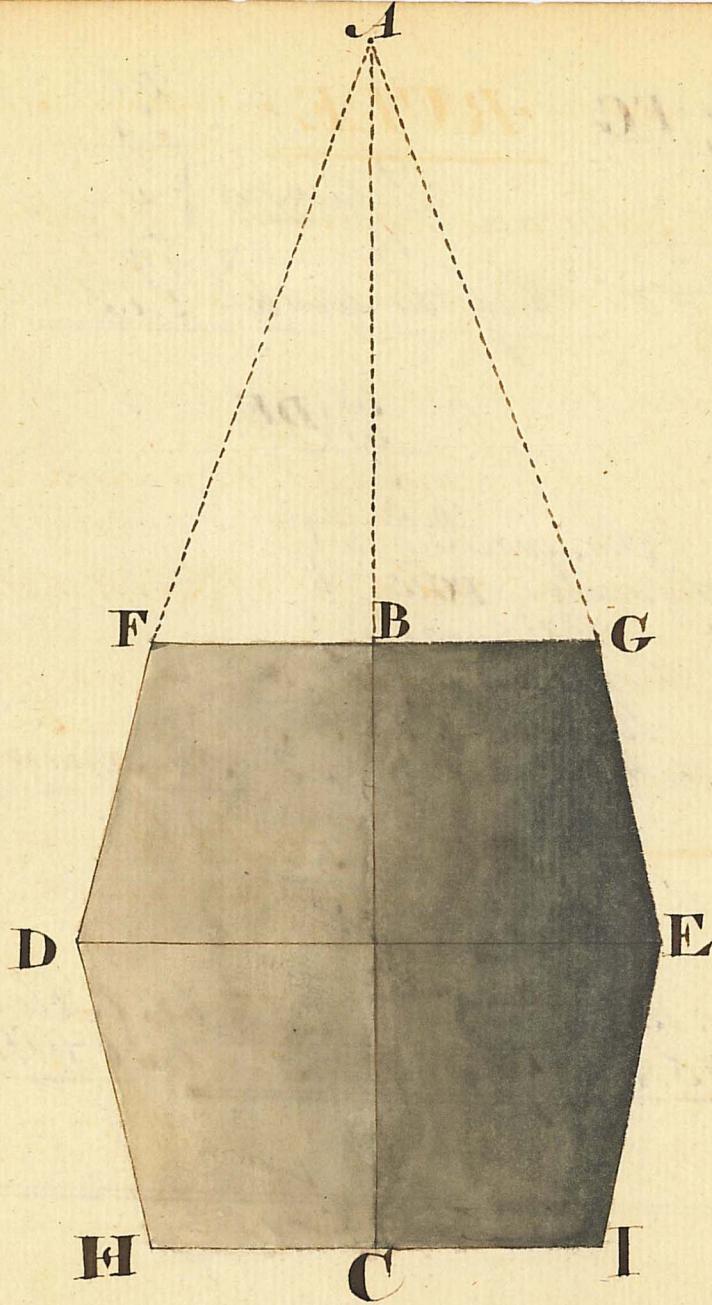
This figure in which  $\Delta AE$  is a cone  $DFGE$ , the  
lower Frustum, and  $DEIH$  is the lower Frustum  
of another cone abutting upon the Base of the  
former cone  $DE$ ; so that  $FGEIHD$  represents  
this Cask whose staves as  $GE$ , &c from Head to  
Bung, are perfectly straight it is plain from the  
Figure that this Cask holds the least of all  
Others of the same dimensions; and to gauge it;

## RULE

From the sum and half sum of the squares of  
the Bung and head Diameters, subtract half  
the square of the difference of the two diameters.  
Multiply the remainder by the Casks Length  
and divide by 1077.15 and 882.354 which will  
give the Content in Ale and Wine Gallons:-

## Example;

Let the dimensions be as before. viz. the Length  
32.5. Bung 31. and Head 24 Inches. I demand  
The Content in Ale and Wine Gallons;-----



$$\begin{array}{r} 24 \\ \times 24 \\ \hline 96 \\ 48 \\ \hline 576 \end{array}$$

$$\begin{array}{r} \text{Difference} \\ \hline 4 \\ 1 \\ \hline 31 \end{array}$$

Half the square = 24.5

$$\begin{array}{r} 31 \\ \times 31 \\ \hline 31 \end{array}$$

The square  $\frac{93}{961}$   
 The square of FG =  $\underline{\underline{576}}$

The sum  $\frac{1537}{1537}$   
 Half the sum =  $\underline{\underline{768.5}}$

The sum  $\underline{\underline{2305.5}}$   
 Subtract half =  $\underline{\underline{24.5}}$  - The square of the diff.

$$\begin{array}{r} 82281.0 \\ - 32.5 \\ \hline BC = 32.5 \end{array}$$

$$\begin{array}{r} 1044.15 \\ - 882.354 \\ \hline 161.805 \end{array}$$

$$\begin{array}{r} 161.805 \\ - 45.62 \\ \hline 68.13 \end{array}$$

161.805	68.13
- 45.62	= 68.13
116.18	= 68.13

68.13 gallons -  
 88.0 litres gallons

Wet Inches; but if the dividend, was the dry  
Inches the product is what it wants to fill it up;

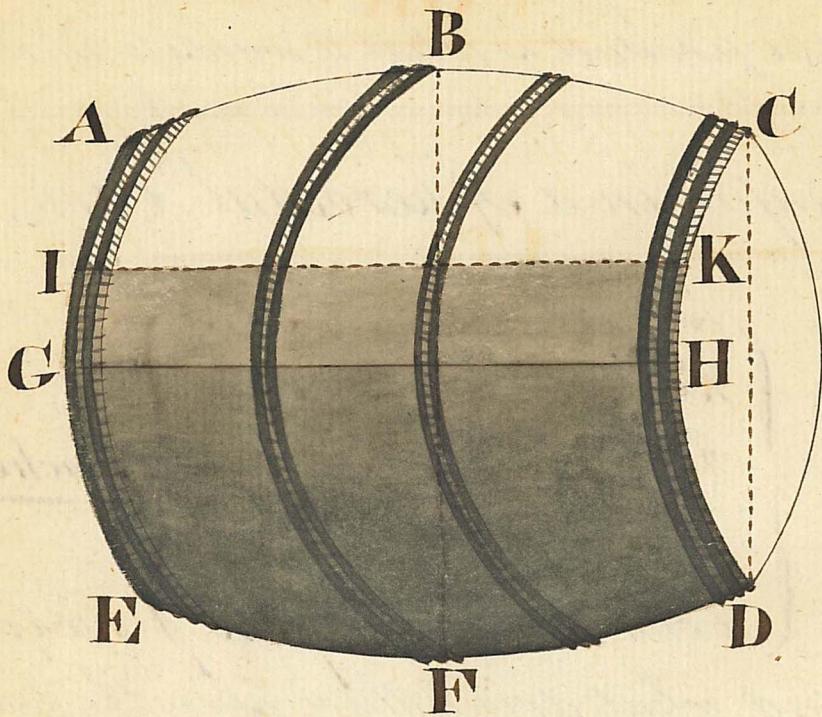
- Example in a Spheroidal Cask; -

admit-	Length	32.5	Inches;
	Bung diameter	31.0	
	Wet	21.0	
	Dry	10.0	
Content		75.3	ale gall;

I demand what drink there is in the cask,  
and how many gallons will fill it up; .....

$$\begin{array}{r} \text{Bung} = 31 ) 21,000 \\ \underline{-} 186 \\ \underline{\underline{-}} 240 \\ \underline{-} 214 \\ \underline{\underline{-}} 26 \\ \underline{-} 214 \\ \underline{\underline{-}} 50 \\ \underline{-} 45 \\ \underline{\underline{-}} 5 \\ \underline{-} 4 \\ \underline{\underline{-}} 1 \\ \underline{-} 1 \\ \underline{\underline{-}} 6 \\ = 86 \text{ rem;} \end{array}$$

Quotient .644



$$\begin{array}{r}
 .6741 \\
 -5000 \\
 \hline
 14.1741 \\
 \hline
 .04435 \\
 -67440 \\
 \hline
 \end{array}$$

The area of segment,  $\frac{1}{14} \cdot 1741$

The content of the cask,  $\frac{1}{14} \cdot 1741 \times 5 =$  Ale gallons.

$50'0225$

$216525$

$368045$

$505225$

In the cask  $54,4042975 =$  Ale gallons

But the Content of a Cask in the  
Form of the lower Frustum of two  
Cones, may be more expeditiously  
found by finding a mean diameter;

### RULE.

To the Head diameter, and half the difference of  
the diameters; to this add one twelfth of the  
Quotient, found by dividing the square of the  
said difference by the sum of the diameters and  
that sum is the mean diameter sought;

2) 80	31	7	24
<u>07 = 12,</u>	<u>12</u>	<u>490.89</u>	<u>3.5</u>
<u>07</u>	<u>4</u>	<u>440</u>	<u>07</u>
<u>31</u>	<u>3.5 = 12 diff;</u>	<u>500</u>	<u>Ans. = 24.37</u>
<u>24</u>		<u>495</u>	
<u>55 sum of diam;</u>		<u>= 5</u>	

Mean diameter 24.37 Answe;

TO,

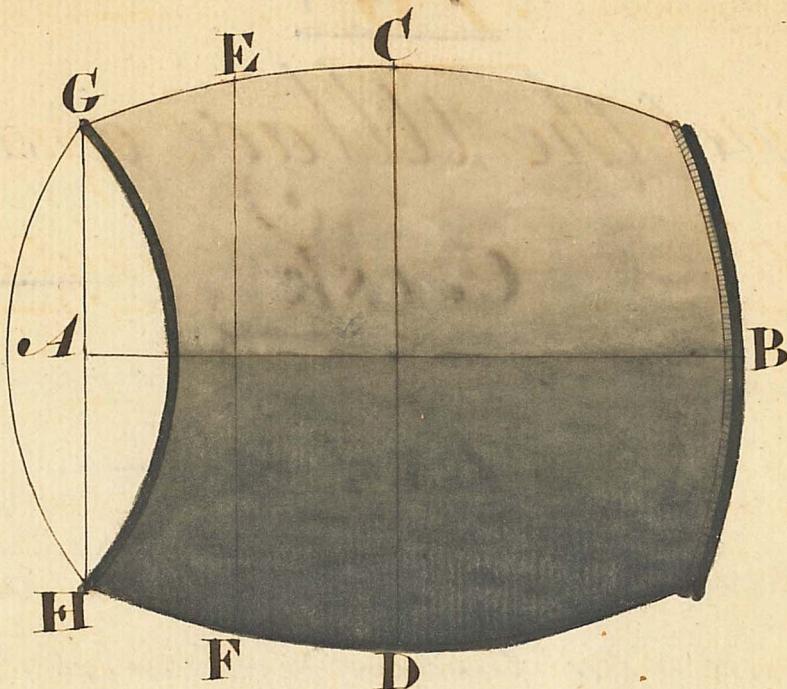
Gauge a Cask, without regarding  
To what Variety it belongs;

RULE,

To the square of the ~~bung~~ diameter add the square of the head, and four times the square of the mean diameter. Multiply the sum by the length of the cask and divide by 2154.3 for Ale, that is twice 1077.15, and by 1764.41 for Wine, that is twice 882.35, and that is the content.

Example:

Admit the length to be 32.5, the ~~bung~~ 31 the Mean diameter 28.85, and the head 2.4 inches. What's the content in Ale and Wine gallons;



The square of the Bung; — 961. 00.

The square of the head; — 5 $\frac{1}{4}$ b. 00

1.5 times square of the mean diam; 33 $\frac{2}{3}$ q. 29

4866. 29

32.5

Ams. Ale & Wine  
13.41 - 89.6;

24331.45

973258

9159887

2154.3	158154.425	73.41
--------	------------	-------

1764.48	158154.425	89.6
---------	------------	------

TO ;

Find the Ullage of a  
Cask;

RULE

Divide the wet or dry Inches by the Bung dia-  
meter and if the Quotient be under .500 subtract  
From the Quotient a fourth part of what that  
Quotient wants of .500 and the remainder is a  
Decimal Fraction which multiply by the content;  
2<sup>nd</sup>; But if Quotient be above .500 add to it  $\frac{1}{4}$ -  
Part of the Excess of the said Quotient above .500  
that sum multiplied by the casks content  
gives the Liquor in the cask if you took the-

FOR

The Vacuity or what will fill it  
UP,

Bung<sup>31</sup>) 10,0000 (3225 Quotient,

$$\begin{array}{r} 93 \\ - 40 \\ \hline 52 \\ - 40 \\ \hline 12 \\ - 10 \\ \hline 2 \\ - 2 \\ \hline 0 \end{array}$$

$$\begin{array}{r} ,5000 \\ ,3225 \\ \hline ,1475 \\ \hline ,014434 \text{ part} \end{array}$$

3225  
04434

The Area of the segm.<sup>t</sup> = 24813  
The Content of Cask = 14534

$$\begin{array}{r} 194691 \\ 83439 \\ 130065 \\ \hline 194691 \end{array}$$

Wazts to fill Cask = 20,9626581

What is in the Cask = 14,1042975

The Casks Content = 45,3699356 - ale gallons.

TO

Find the Ullage of a Standing  
Cask;

RULE.

1. From the square of the Bung diameter, subtract the square of the head diameter and divide the square root of the remainder by half the Casks Length,
2. Multiply this Quotient by the Number of Inches which the diameter sought is distant from the Bung and call this product your Subduend.

Lastly, From the square of the Bung diameter subtract the square of your Subducend, and the square root of the remainder is the Diameter sought.

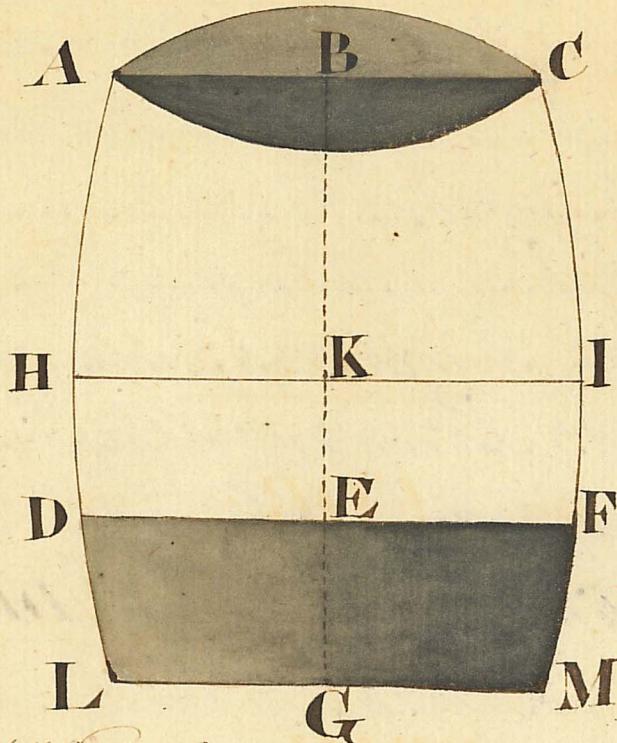
Let us suppose a spheroidal cask posited as before the length 32.5 Inches, the Bung 2 $\frac{1}{2}$  the head 23. The content of this cask will be, 59.95 ale gallons. Then let the wet inches be 8.5. I demand the diameter **DE**, and how much liquor there is in the cask;

$\begin{array}{r} 2 \frac{1}{4} \\ - 2 \frac{1}{4} \\ \hline 1 \frac{8}{9} \end{array}$	<b>III.</b>	$\begin{array}{r} 2 \frac{3}{4} \\ - 2 \frac{3}{4} \\ \hline 6 \frac{9}{16} \end{array}$	<b>LC.</b>
$\begin{array}{r} 5 \frac{4}{16} \\ - 4 \frac{29}{16} \\ \hline 1 \frac{52}{16} \end{array}$		$\begin{array}{r} 4 \frac{16}{16} \\ - 5 \frac{29}{16} \\ \hline 1 \frac{15}{16} \end{array}$	
$2 \frac{1}{4}$		$1 \frac{15}{16}$	
$2 \frac{1}{4}$		$1 \frac{15}{16}$	

$$16.25 = \text{half length}$$

$$8.5 = \mathbf{EG}$$

$$= 4.45 = \mathbf{KE}$$



~~16.25) 14,170.842~~  
~~13 000~~  
~~- 11400~~  
~~11345~~  
~~- 325~~  
~~325~~

<del>849</del> <del>145</del> <del>360</del> <del>6104</del> <del>6104</del> <del>615800</del> <del>6145800</del>	<u>KE</u> <u>III</u> <u>145</u> <u>360</u> <u>6104</u> <u>6104</u> <u>615800</u> <u>6145800</u>
---	--

} subducend;

~~354064~~  
~~33490~~  
~~44306~~

Square. of the ~~40548~~  
15,670564 - Subducend

$$\begin{array}{r}
 729.000000 = \text{Bung diameter squared} \\
 45.670564 = \text{Subducend squared} \\
 \hline
 683.329436 [26.140; diameter]
 \end{array}$$

$$\begin{array}{r}
 16) 283 \\
 246 \\
 \hline
 52) 1732 \\
 1521 \\
 \hline
 5224) 21194 \\
 20896 \\
 \hline
 52280) 29836
 \end{array}$$

Ans. 26.140 Diam. DE  
 Diam. DE

## FOR

The Content of the Frustum;

### DFML;

So twice the square **DF** = 1362.42

Add the square **LM** = 529.00

The wet Inches,  $\frac{1891.42}{8.5}$

$945710$

$1513130$

$1099.15 - 16099.010$  14.9 ale.

The Casks whole content, 150.9

Shee wants to fill the cask  $14.9 - 15.0 =$  Ale gallons;

# MALT= GAUGING;

Suppose a Cisternes Length 85 Inches, Breadth 54.4 Inches, and depth 36 Inches. And just before the draining of it, it is gauge exactly full; What is the content and net Bushels.

54.4		
85		
2920		
1352		
46240		
36		
242440		
1384920		
21504 - 1661640	44.4	Bushels gross
	.8	
	64.92	Net Bushels;

# SHEWING;

How to find the exact distance  
to any Object that's visible without  
an Instrument or actually.—

Measuring of the Distance that  
is required; —

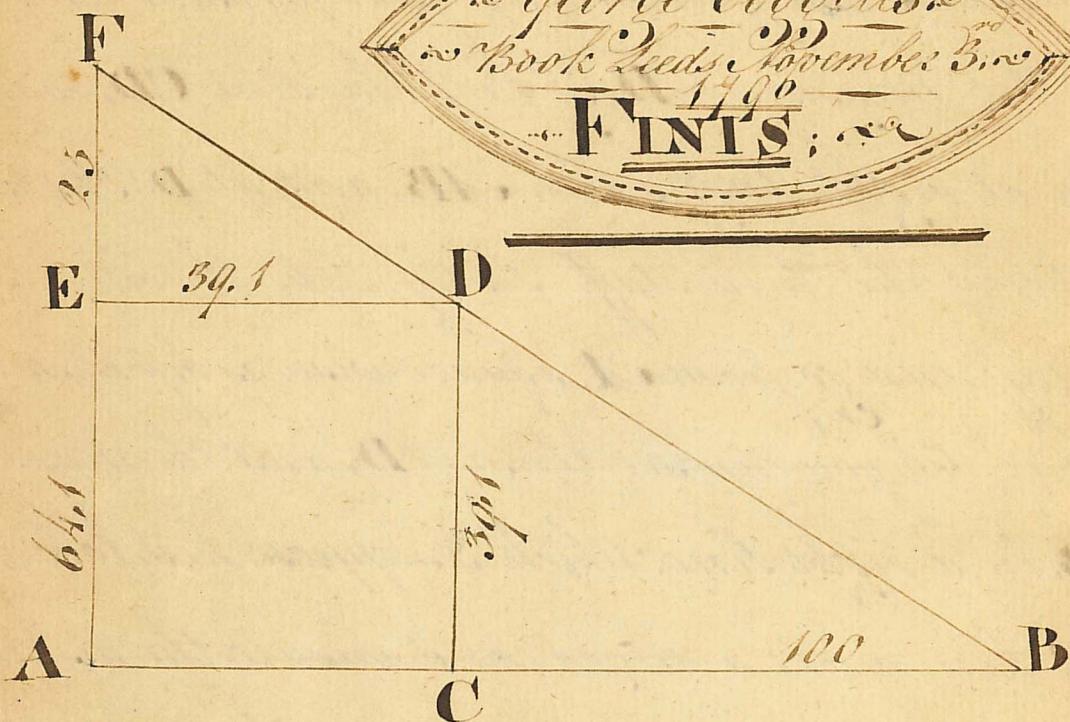
There are several ways known to Geometrians  
to take the distance of places one from another or  
from your Station to any place seen at a distance  
But withal there must be an Instrument—  
used to take angles at two stations and often  
times Trigonometry is called in to their;.....

- assistance, My Business shall be here to shew  
how to perform the same without an Instrument,

## Example;

Get four straight sticks it matters not whether  
they be all of a length or not; an then set it be-  
required to measure the distance **AB**, upon-  
some plane level ground; at **A** thrust down  
one the sticks; there stand, and order an-  
Adjuster to thrust another down at **C**, so that  
standing at **A**, you may see the staff **C**, and  
the mark at **B**, both in a right line; Now it  
Matters not at what distance the staff **A** is-  
from the staff **C**; but if your distance required  
be large, then the farther **C** is from **A**,

the better,) Then take a third staff and go from C. any Number of feet. yards, or any other Measure to D. so that the line CD. may be at right angles with AB. and at D. Thrust down the third staff. Lastly. Take the other staff and go from A. square-wise, as before. so far. till you can see the staff D. and the mark B. in a right line. Which I suppose here to be at E. here make a Mark. and measure the distance FE. 25 Feet &c. And EA. 39. 1. Then FE. 25- added to EA. 39. 1 make EA. 64. 1 feet. by measuring CD equal to AE. I find it to be 39. 1 - Now the <sup>Truth</sup> of this Performance is grounded upon Familiar Triangles. for the Triangle FED is similar to the triangle FAB. therefore it will hold.



$$FE : ED :: F. 4$$

$$\text{As } 25 : 39.1 :: 64.1$$

$$\frac{39.1}{64.1}$$

$$\begin{array}{r} 5469 \\ 1923 \end{array}$$

$$\begin{array}{r}
 25 \\
 \hline
 15 \quad \left\{ \begin{array}{r} 5 \\ 5 \end{array} \right. \\
 \hline
 250631 \\
 - 301262 \\
 \hline
 1002524 \quad \text{Answer B.}
 \end{array}$$

